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# Comparing Internal Models to Rating Criteria

Andrew Smith and Grisha Spivak

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## Background

- Most European insurers now calculate their Solvency Capital Requirement (SCR) using an Internal Model or the Solvency II Standard Formula.

- At the same time, many of these insurers use credit ratings, for demonstrating financial strength to policyholders, for risk management of credit-risky assets and for calculating a matching adjustment. Ratings may come from an external credit ratings agency or an internal credit ratings department.

- Both SCR and ratings calculations involve models of rare but severe financial losses.

- In this session we compares attributes of rating methodologies to internal models.

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## Disclaimer

- While there are common themes, different firms have built their internal capital models in different ways.

- Likewise, while rating agency methods have common themes, there are methodology differences between agencies and between rated instruments.

- This presentation provides high level methodology comparisons. It is not an authoritative statement of the methodology of a particular rating agency or the internal model of any firm.

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## Presentation Overview

- Probabilities

- Dimensionality

- Correlations

- Bottom line adjustments

- Where Solvency II and Ratings Interact

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## Probabilities and Levels of Confidence

- S2 Capital models use explicit probabilities
  - SCR = 99.5%, Value-at-risk, 1-year horizon

- For internal models, the SCR is calculated at the 99.5%-ile from a simulated distribution of losses.



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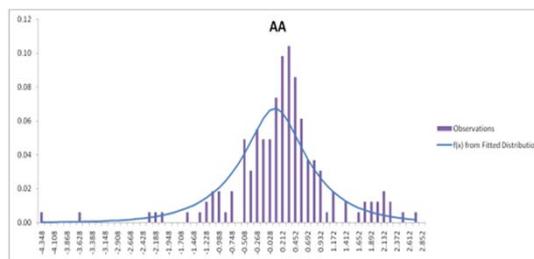
## Rating Scales: Comparing Different Agencies

| EIOPA/ EBA/ ESMA | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| AM Best | aaa | aa+, aa, aa- | a+, a, a- | bbb+, bbb, bbb- | bb+, bb, bb- | b+, b, b- | ccc+, ccc, ccc-, ccc, c |
| Fitch | AAA | AA | A | BBB | BB | B | CCC, CC, C |
| Moody's | Aaa | Aa | A | Baa | Ba | B | Caa, Ca, C |
| S&P | AAA | AA | A | BBB | BB | B | CCC, CC, C |

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# Use of Solvency II in Rating Insurers

**Solvency II**

- Assets at fair value

- Liability using BEL + Risk Margin

- Items of regulatory forbearance:

  – Ultimate forward rate

  – Matching / volatility adjustment

  – Transitional measures

  – Reinsurance of risk margins

  – No risk charge for sovereigns

  – US Equivalence

**Credit Rating Analysis**

- Rating agencies may strip out elements of regulatory forbearance in order to improve comparability.

- Fitch and S&P have published spreadsheet models.

- Generally rating agencies seem more sympathetic to MA/VA than to UFR and transitional measures.

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# S&P Historic Default Rates (Global Corporate)



Chart 4

Global Corporate Average Cumulative Default Rates By Rating (1981-2014)

Sources: Standard & Poor's Global Fixed Income Research and Standard & Poor's CreditPro®.

© Standard & Poor's 2015.
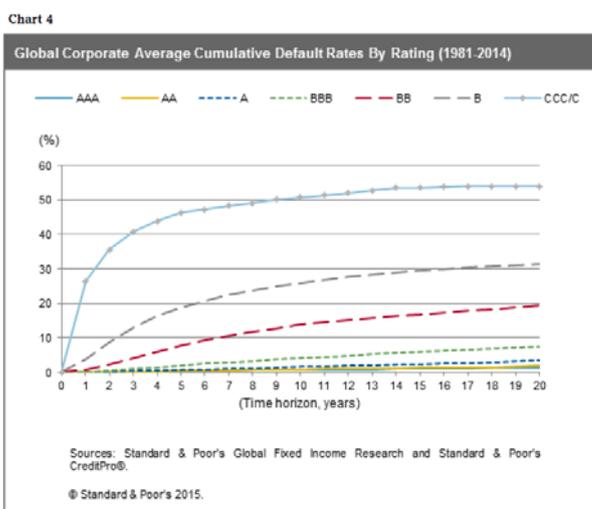
Credit rating methodologies are designed to express fundamental longer term aspects of the asset's credit quality, not affected too much by the short term market volatility. Internal Models are designed to be market consistent, and as such can produce quite volatile solvency ratios in the short term.

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# Comparing S2 Probabilities to Rating Defaults

- S2 Probabilities are based on a model (which is partially calibrated to history)

- Suppose we have 10 000 firms with internal model probability 99.7% of survival

- How many will still be there in a year's time?

- Rating agency probabilities are historic frequencies of bond defaults

- Up to 100 years of data, 1000s of companies.

- Ratings (in early years) function of deterministic calculations.



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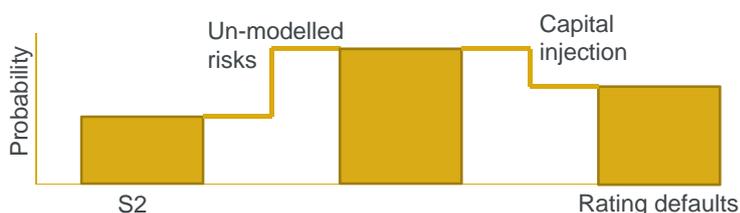
# "Idealized" Default Rates (Structured Finance)

Moody's "Idealized" Default Rates

| | Rating Factor | Rating | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Year | | | | | |
| 1 | 1 | Aaa | 0.0000% | 0.0001% | 0.0002% | 0.0007% | 0.0018% | 0.0029% | 0.0040% | 0.0052% | 0.0066% | 0.0082% | 0.0100% |
| 2 | 10 | Aa1 | 0.0000% | 0.0006% | 0.0030% | 0.0100% | 0.0210% | 0.0310% | 0.0420% | 0.0540% | 0.0670% | 0.0820% | 0.1000% |
| 3 | 20 | Aa2 | 0.0000% | 0.0014% | 0.0080% | 0.0260% | 0.0470% | 0.0680% | 0.0890% | 0.1110% | 0.1350% | 0.1640% | 0.2000% |
| 4 | 40 | Aa3 | 0.0000% | 0.0030% | 0.0190% | 0.0590% | 0.1010% | 0.1420% | 0.1830% | 0.2270% | 0.2720% | 0.3270% | 0.4000% |
| 5 | 70 | A1 | 0.0000% | 0.0058% | 0.0370% | 0.1170% | 0.1890% | 0.2610% | 0.3300% | 0.4060% | 0.4800% | 0.5730% | 0.7000% |
| 6 | 120 | A2 | 0.0000% | 0.0109% | 0.0700% | 0.2220% | 0.3450% | 0.4670% | 0.5830% | 0.7100% | 0.8290% | 0.9820% | 1.2000% |
| 7 | 180 | A3 | 0.0000% | 0.0389% | 0.1500% | 0.3600% | 0.5400% | 0.7300% | 0.9100% | 1.1100% | 1.3000% | 1.5200% | 1.8000% |
| 8 | 260 | Baa1 | 0.0000% | 0.0900% | 0.2800% | 0.5600% | 0.8300% | 1.1000% | 1.3700% | 1.6700% | 1.9700% | 2.2700% | 2.6000% |
| 9 | 360 | Baa2 | 0.0000% | 0.1700% | 0.4700% | 0.8300% | 1.2000% | 1.5800% | 1.9700% | 2.4100% | 2.8500% | 3.2400% | 3.6000% |
| 10 | 610 | Baa3 | 0.0000% | 0.4200% | 1.0500% | 1.7100% | 2.3800% | 3.0500% | 3.7000% | 4.3300% | 4.9700% | 5.5700% | 6.1000% |
| 11 | 940 | Ba1 | 0.0000% | 0.8700% | 2.0200% | 3.1300% | 4.2000% | 5.2800% | 6.2500% | 7.0600% | 7.8900% | 8.6900% | 9.4000% |
| 12 | 1350 | Ba2 | 0.0000% | 1.5600% | 3.4700% | 5.1800% | 6.8000% | 8.4100% | 9.7700% | 10.7000% | 11.6600% | 12.6500% | 13.5000% |
| 13 | 1766 | Ba3 | 0.0000% | 2.8100% | 5.5100% | 7.8700% | 9.7900% | 11.8600% | 13.4900% | 14.6200% | 15.7100% | 16.7100% | 17.6600% |
| 14 | 2220 | B1 | 0.0000% | 4.6800% | 8.3800% | 11.5800% | 13.8500% | 16.1200% | 17.8900% | 19.1300% | 20.2300% | 21.2400% | 22.2000% |
| 15 | 2720 | B2 | 0.0000% | 7.1600% | 11.6700% | 15.5500% | 18.1300% | 20.7100% | 22.6500% | 24.0100% | 25.1500% | 26.2200% | 27.2000% |
| 16 | 3490 | B3 | 0.0000% | 11.6200% | 16.6100% | 21.0300% | 24.0400% | 27.0500% | 29.2000% | 31.0000% | 32.5800% | 33.7800% | 34.9000% |
| 17 | 4770 | Caa1 | 0.0000% | 17.3816% | 23.2341% | 28.6386% | 32.4788% | 36.3137% | 38.9667% | 41.3854% | 43.6570% | 45.6718% | 47.7000% |
| 18 | 6500 | Caa2 | 0.0000% | 26.0000% | 32.5000% | 39.0000% | 43.8800% | 48.7500% | 52.0000% | 55.2500% | 58.5000% | 61.7500% | 65.0000% |
| 19 | 8070 | Caa3 | 0.0000% | 50.9902% | 57.0088% | 62.4500% | 66.2420% | 69.8212% | 72.1110% | 74.3303% | 76.4853% | 78.5812% | 80.7000% |
| 20 | 10000 | Ca | 0.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% |
| 21 | 10000 | C | 0.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% | 100.0000% |

Source: Moody's Investors Service

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# Presentation Overview

- Probabilities
- <span style="color:red">Dimensionality</span>
- Correlations
- Bottom line adjustments
- Where Solvency II and Ratings Interact

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# Dimensionality: Solvency II Model vs Ratings Model

- Solvency II standard formula has tens of stresses, internal models may have hundreds.

- Internal model risk scenarios are applied to multiple contracts and business units, but with one year horizon.

- A single business unit may be exposed to a handful of risk drivers.

- The idea is to develop risk distributions based on history that are independent of business strategy and exposures.

- Rating agencies categorise instruments according to their economic exposures, and use methodologies tailored to the instrument being rated.

- For a given instrument, the stresses are developed at different rating levels, in a small number of key drivers.

- The rating is the highest level at which the stress tests pass (subject to judgemental modification).

- Stresses typically cover multiple years.

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# Example House Price Stresses (source: Moodys)

## Appendix 1: Base Assumptions for Housing Prices and Interest Rates

The following show an example of a base case for future housing prices and interest rates in the US and UK for different rating categories.

EXHIBIT 1-1
**US and UK Base Case Assumptions for Housing Price and Interest Rates**

| Target Rating | Aaa (sf) (US) | Aaa (sf) (UK) | Aa2 (sf) | A2 (sf) | Baa2 (sf) | Ba2 (sf) | B2 (sf) |
|---|---|---|---|---|---|---|---|
| x% decline over 1 year | 30* | 35* | 25 | 20 | 15 | 10 | 0 |
| HPI returns to 100 | Never | Never | 20.5 years | 12.5 years | 8 years | 5 years | N/A |
| Growth rate after 1 year | 0% | 0% | 1.5% | 2.0% | 2.5% | 3.0% | 3.0% |
| Interest Rate Level | 1% | 1% | 2.5% | 3.0% | 3.5% | 4.0% | 4.0% |

- This will be based on the then prevailing country specific MILAN decline assumption

*Source: Moody's Investors Service*

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# Assigning Events to Credit Ratings

- In Solvency II there are various ways of defining a "1-in-200" event, mostly based on fitted distributions.
  - Governance compares 1-in-200 to recent events, eg 2008 credit crunch.
- In the same way, for ratings, stresses are associated with particular rating levels.
  - Illustration: there might be a judgement that the 2008 credit spread widening was a "BBB event", ie that any bond rated BBB or above should be able to survive another 2008.
  - AAA and AA typically worse than anything that has happened recently.
  - Approved within rating agencies by committees that try to ensure consistency.
  - Statistical procedures less rigid than for internal model approval.

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## Methods of Allowing for Correlations

| Combined Stresses | If two risks are highly correlated, apply the corresponding stresses on top of each other. | Methods used in credit ratings. |
| --- | --- | --- |
| Simultaneous Stresses | It two risks are unrelated, require each risk stress to pass when applied on its own. | |
| Correlation | Link risks using correlation assumptions or copulas. | This is how SF and many IMs work. |
| Rating Caps | Cap rating of a subsidiary at the group rating or the rating of other bankruptcy-linked entity. Cap group rating at home government rating. | Used in credit ratings. |

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## Transparency of Methodology

- The S2 Standard Formula is fully public.

- Before the 2008 financial crisis, rating agency methodologies were closely guarded secret intellectual property.

- Since the crisis, rating agencies have published methodologies, including quantitative stress test information. All the rating agency information in this presentation is taken from the public sections of the agency web sites. Thus far, this candour has stalled demands for more regulation of rating agencies.

- S2 internal models remain proprietary to each firm, although information is disseminated through consultant surveys, regulatory benchmarks and people moving jobs.

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## Use of Judgement in Internal Models

**S2 Model: Judgement at Start**

Judgement → Internal Model → SCR/Percentile
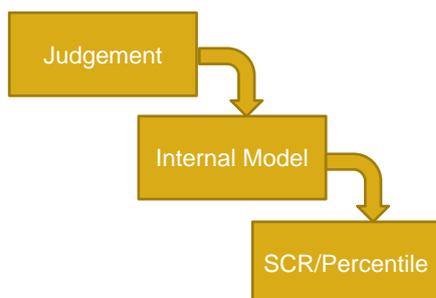
**Rating Model: Judgement at the End**

Stress Testing → Draft Rating → Judgemental Notching

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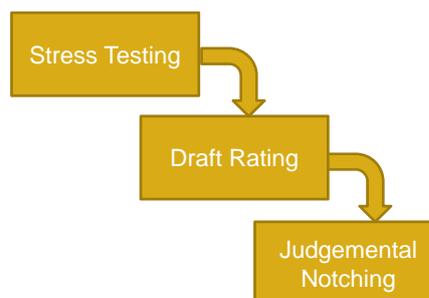
## Comparison of Judgement Process

**Internal Model Governance**

- Risk committee approves internal model calibration decisions.
- Reports submitted on approval, containing technical justification and commercial impact.
- To what extent are decisions discussed and voted by peers?
- Additional regulatory review.

**Credit Rating Agency**

- Every credit rating goes through a very clear defined governance process, gets discussed by a committee of rating analysts, who then vote to make a decision.
- Impact of non-balance-sheet factors: market position, earnings, strength of ALM capability, ownership, governance.
- Commercial influence?

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## Role of Benchmarking and Freedom of Judgement

**Internal Models**

- In theory, IM firms are free to choose appropriate assumptions provided these are justified.

- In the regulatory approval process, firms worry about levelling up and regulators worry about levelling down.

- Substantial incentives to herd behaviour although seldom explicit in internal model submissions.

**Internal Ratings**

- Internal ratings professionals (for rating non-publically-rated structures) have to produce ratings of comparable strength to those published.

- Effectively have to benchmark their methodologies against those published by rating agencies.

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## Example: Matching Adjustment Portfolio

- Liability discount rate based on matching asset portfolio yield

- Minus credit adjustment (fundamental spread)

- Largely immunised to spread moves because these affect assets and liabilities equally

- The main mismatch is of downgrades (a higher FS might apply, or an asset may cease to be MA eligible)

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## Fundamental Spread (Allowance for Defaults)



10 Year Fundamental Spread (GBP) at 30/09/2016

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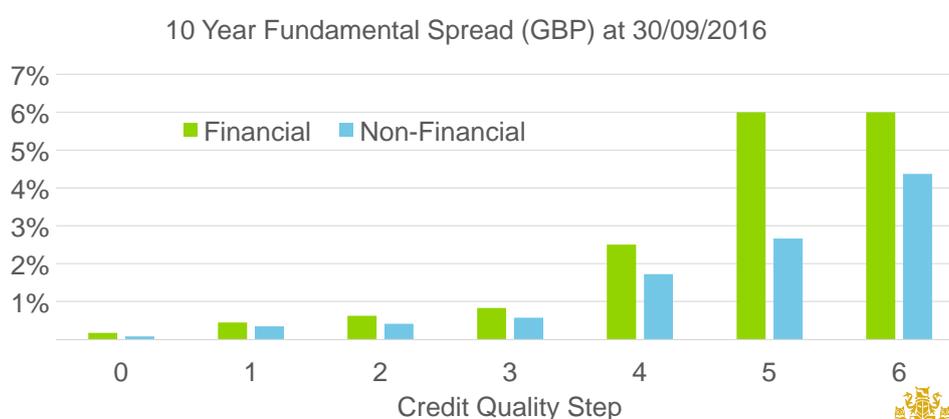
## Modelling Migrations: Reduced form Model

**Table 22**

| Average One-Year Corporate Transition Rates (1981-2014) (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| From/to | AAA | AA | A | BBB | BB | B | CCC/C | D | NR |
| **Europe** | | | | | | | | | |
| AAA | 82.67 | 11.27 | 0.63 | 0.21 | 0.00 | 0.00 | 0.21 | 0.00 | 5.01 |
| AA | 0.28 | 84.38 | 10.84 | 0.62 | 0.00 | 0.00 | 0.00 | 0.00 | 3.89 |
| A | 0.02 | 2.00 | 86.34 | 6.12 | 0.23 | 0.02 | 0.00 | 0.05 | 5.24 |
| BBB | 0.00 | 0.12 | 4.48 | 82.96 | 4.25 | 0.44 | 0.12 | 0.09 | 7.55 |
| BB | 0.00 | 0.00 | 0.11 | 5.25 | 71.82 | 7.96 | 0.51 | 0.51 | 13.83 |
| B | 0.00 | 0.00 | 0.06 | 0.47 | 7.35 | 69.88 | 4.41 | 3.00 | 14.82 |
| CCC/C | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 15.82 | 37.85 | 27.12 | 19.21 |

Source S&P 2014 Rating Study

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## Modelling Migrations: Look through to Underlying



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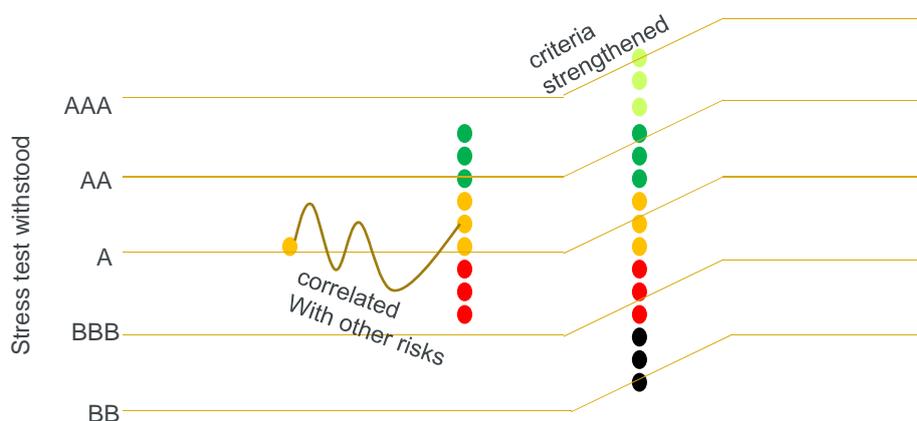
**Questions**

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